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Air-Conditioning, Heating, and Refrigeration Institute

DOCKET
10-BSTD-01
DATE SEP 07 2011
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September 7, 2011

California Energy Commission (CEC)

Re: AHRI Comments on Motor Efficiency Measures (Docket Number 10-BSTD-01; "August 17, 2011 Staff Workshop – 2013 Building Energy Efficiency Standards")

Dear CEC Staff:

The Air-Conditioning, Heating and Refrigeration Institute (AHRI) is the trade association representing manufacturers of heating, cooling, water heating, and commercial refrigeration equipment including manufacturers of commercial HVAC pumps. More than 300 members strong, AHRI is an internationally recognized advocate for the industry, and develops standards for and certifies the performance of many of the products manufactured by our members. In North America, the annual output of the HVACR industry is worth more than $20 billion. In the United States alone, our members employ approximately 130,000 people, and support some 800,000 dealers, contractors and technicians.

We would like to provide you with some comments on the presentation, "ASHRAE 5 ECM Motors" that was discussed at the CEC staff workshop on August 17, 2011, and the report titled, "Draft Measure Information Template – Fractional Motors":

VAV air terminals

- The series fan powered VAV air terminal with an ECM motor is more energy efficient than a parallel fan powered VAV air terminal. Therefore, the series fan powered VAV air terminal must not be disallowed.

- The energy payback for a parallel VAV air terminal unit with an ECM has been proven to be longer than a normally accepted capital payback and is therefore not typically recommended.

- The energy savings payback for a series VAV air terminal unit with an ECM has been proven to be within typically payback range and is recommended.

Attached is a letter that supports the above comments. The letter was submitted on September 5, 2011 by Mr. Gus Faris, Vice Chairman of AHRI's Air Control and Distribution Devices Section (ACDD).

Motors

Comments on the code change proposal with respect to Section 144(c)4:

- This rule applies to all HVAC, but the associated analysis was for series fan-powered VAV boxes greater than or equal to 1/12 HP. HVAC includes many other products, such as fan coils, variable refrigerant flow, energy recovery devices, and pumps.

There was no analysis shown to indicate a fair payback with respect to efficiency gains for ECM motors in these applications or for motors less than 1/12 HP. Many of these products already have motors that are less than 1/12 HP.

- There are many belt-driven fan devices (blower coils) on the market that are 1 HP or less. Currently, there are no ECM motors on the market configured for use in belt-driven products. How does CEC plan to address this situation?

- Many blower coils use 3-phase motors. While 1 HP and greater 3-phase motors will meet the efficiency requirements under EPACT, motors smaller than 1 HP have no officially recognized method to determine their efficiency. How will this issue addressed?

- The HVAC portion of the proposed regulation makes no exceptions for motor voltages that are outside the range of voltages provided by ECM manufacturers at this time (115V to 277V single phase).

Lastly, we feel that prescriptive measures with respect to components can cause issues with efficiency as optimal components do not always lead to optimal systems and hinders manufacturing innovation at the system level.

AHRI appreciates the opportunity to provide these comments. If you have any questions regarding this submission, please do not hesitate to contact me.

Sincerely,

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September 5, 2011

California Utilities Statewide Codes and Standards Team

Re: Draft Measure Information Template – Fractional Motors

Ladies and Gentlemen:

Thank you for the opportunity to review the Power Point presentation, "ASHRAE 5 ECM Motors" that was presented in the August 17th CEC Workshop and the report, "Draft Measure Information Template – Fractional Motors" by Taylor Engineering, LLC.

My name is Gus Faris. I am Vice-President, Engineering for Nailor Industries, Inc. I was also the chair of ASHRAE RP-1292 and the chair of the Variable Air Volume Research Consortium, whose final report is reprinted in your report. These are the most recent and definitive research projects on the subject covered in your publications listed above. I also serve as liaison from both organizations to ASHRAE TC 7.7, ASHRAE TC 5.3 and AHRI ACDD section, all sponsors of the ASHRAE RP-1292 project and now owners of the consortium's research. I also serve as the designated liaison representing ASHRAE TC 5.3 and AHRI ACDD section to ASHRAE Standard 90.1 regarding use of the research listed above for ECM motors as applied in fan powered VAV terminal units, both series and parallel. Serving in these positions puts me in a unique position to evaluate the products and draw conclusions about their relative performance and to comment on the presentation and the proposed code changes.

I have the following comments and suggestions.

It seems that, for the most part, the research and suggestions were correct and in alignment with current industry knowledge. Although there are 2 major and 2 minor exceptions that I found.

1. On slide 6 it would have been nice to recognize Nailor Industries, Inc.'s catalog data when using it similar to recognizing EBM-Pabst's on slide 7.
2. On slide 10, you should include some controls costs when applying ECM's to fan coils. I know this is not the subject matter, but they are somewhat different from terminal units in the types of controls desired vs. what is currently in use to optimize energy savings. This will incur larger first costs, but the run times are longer, so the overall conclusion should not change.
3. On slide 13 there is the proposal that parallel units should be exempt. This is an egregious error.
    a. This continues on slide 14 with the claims, "No impact on cooling load" and "Decreases heating load."
    b. On slide 16, this continues with Exception 1, but again, there is no exception justified.
    c. On slide 17 this continues with the suggestion that series units should be replaced with parallel units.

4. In the code document on page 7, you state that state that there has been relatively no push-back from the industry or stake holders. This may be true, but neither ASHRAE TC 5.3 nor AHRI Section ACDD was contacted, and yet that is where every manufacturer of this equipment is represented, and these groups have been the most active for promoting research in energy efficiency of these units.
5. On page 9 of the code document, you repeat the items listed above in number 3.

Items 1 and 2 above are self explanatory. The major issues are in 3, 4 and 5 above. Three and five are identical. Here is the supporting data.

PRIMARY AIR LEAKAGE

You did not consider the impact of the primary air leakage of the parallel unit just like ASHRAE Standard 90.1, Appendix G did not. A terminal unit is an assembly of components and the unit energy efficiency must be addressed on at least two fronts, motor energy efficiency and terminal primary air leakage. See page 3 of the consortium document. In the second paragraph, they discuss RP-1292. In RP-1292, the parallel and series units were evaluated using only PSC motors. This was done so as to not confuse the research on the motor types and that of the terminal unit types. RP-1292 was a comparison of the terminal unit types. When discussing the primary air leakage, the report states, "… for the parallel FPTU's, leakage must be accurately characterized and included when modeling overall energy use. Any amount of leakage from a parallel unit requires an increased amount of primary energy because the fan has to make up for the leakage." It goes on to state, "They found that high leakage (greater than 10%) in parallel units can completely negate the expected energy benefits that parallel units might have over series units." Reading from RP-1292, one finds that the arithmetic leakage average on the units tested was above 10%. Pages 64 through 69 of the consortium report describe the leakage. Pages 158 through 165 list all of the leakages measured. It is important to note that this is all casing leakage, and that for the series unit the casing leakage (what very little there is) has little to no impact on the FPTU energy consumption. The bottom line on the parallel unit is that if the unit has zero primary air leakage, the most improvement on energy use that can be expected is 17%. That is it. As the typical leakage of primary air in a parallel unit is between 5 to 20%, the energy savings obtained using a parallel unit vs. a series unit can be neutralized, and it is possible that the parallel unit will consume more energy than the series unit. And the energy consumption comparison was found to be minimal at best between the series and parallel units with the leakages found and both using PSC motors. See below for a comparison of the parallel and series units.

There are 11 papers that have been written and presented at ASHRAE to date on this research. More are coming. I wrote one of them as a recap of all the findings in 1292, ***Reflections on ARI/ASHRAE Research Project RP-1292, Comparison of the Total Energy Consumption of Series versus Parallel Fan Powered VAV Terminal Units,*** ASHRAE paper CH-09-033 (RP-1292). The following comparisons were included.

PARALLEL UNIT	SERIES UNIT
• **Positive internal casing pressure**	• **Neutral internal casing pressure**
• **Primary air leaks outward bypassing the zone**	• **Plenum air leaks inward replacing plenum air pulled into the induction port**
• **Highest leakage at full cooling**	• **Lowest leakage at full cooling**
• **Typical leakage is between 5% & 20%**	• **Typical leakage not measured**
• **Average leakage is above 10%**	• **No effect to energy**
• **All bypassed primary air must be replaced by additional primary air to satisfy the zone requirements**	• **No effect**
• **At full load, the unit may be undersized**	

ENERGY USE

PARALLEL UNIT	SERIES UNIT
• **USES 17% LESS ENERGY THAN SERIES UNIT WITH 0% LEAKAGE**	• **USES 5.5% LESS ENERGY THAN PARALLEL UNIT WITH 20% LEAKAGE**
• **USES 3-4% LESS ENERGY THAN SERIES UNIT WITH 10% LEAKAGE**	• **UNITS ARE EQUAL IN ENERGY USE FOR ALL PRACTICAL PURPOSES**
• **MAXIMUM LEAKAGE CAN BE IN EXCESS OF 30%**	
• **TYPICAL LEAKAGE WILL BE BETWEEN 5 AND 20%**	

ECM vs. PSC MOTOR TYPE

When the energy difference in the parallel and the series units between the motor types were analyzed in the consortium's research, the ECM was seen to improve the energy consumption of the series unit by **67%**. This is above and beyond the point where the units were considered to be equal and far in excess of what the parallel can recapture with an unreachable 0% leakage. Further savings can be had in the series unit if one arranges the control algorithms to operate the unit in a VAV fan mode reducing the plenum heat introduced into the zone in part load conditions.

Further complications arise when the designer decides to use low temperature primary air and parallel units to temper the primary air prior to zone delivery. Using low temperature air in the primary duct system has been a very common practice to lower fan energy at the air handler by reducing the air volume required to deliver the same cooling capacity to the zone. Typically, this involves running the fan in the fan powered VAV terminal unit during the cooling mode. While this reduces back draft damper leakage in the parallel unit, it increases the casing leakage due to the increased internal pressure in the mixing chamber of the unit. It also adds the motor heat back to the air stream in the cooling mode as well as the plenum heat (which is measured and accounted for in the series unit but not in the parallel unit when the two are equal) thereby further increasing the parallel energy consumption. See the next chart of usage comparisons. Further, since the motor runs in the heating mode, the heat from the motor is counted in the heat required for the zone. Removing that heat would require heat from another source to satisfy the zone. This heat was accounted for in RP-1292 and used to arrive at the no difference finding. Therefore, it cannot be used to disqualify the series unit. So the claim listed in 3.a. above, "No impact on cooling load," is false.

ISSUE	PARALLEL	SERIES
LOW TEMPERATURE AIR	POOR CONTROL	AVAILABLE OPTION
DEDICATED OUTDOOR AIR SUPPLY	POOR CONTROL	AVAILABLE OPTION
FIRST COST	INCREASED	UNCHANGED
OPERATING COSTS	INCREASED	UNCHANGED
90.1 REQUIREMENT TO COUNT MOTOR HORSEPOWER	NO	YES
INCREASED AIR HANDLER HP	YES	NO
NOISE LEVELS	VARIABLE	CONSTANT
COMFORT LEVELS	VARIABLE	CONSTANT
62.1 ALLOWS CREDIT FOR RECIRCULATED AIR REDUCING OUTDOOR AIR REQUIREMENTS	NO	YES
POTENTIAL SAVINGS WITH ECM MOTORS	NO	YES

Since, as listed in item 4 above, different conclusions would have been reached should the manufacturers of the equipment have been consulted, you should not attempt to remove the series fan powered VAV terminal unit in favor of the parallel, especially since it does not improve energy efficiency as suggested. This does create a conundrum – what to do with the parallel unit and the ECM? Certainly, the ECM is not required or potentially even desirable in the parallel unit. But that does not mean that the series unit is not the better choice for low energy consumption. Exempting the parallel unit from the ECM requirement simply allows the parallel unit to become a more economical first cost selection and a less attractive operating cost selection thereby rewarding the poorer selection of terminal type. Since all manufacturers of the fan powered VAV terminal units make both types, they both will continue to be available, so it would be difficult but maybe not impossible to outlaw one or the other. I would suggest some sort of penalty for use of the parallel unit in lieu of the series unit with the ECM operated in a VAV fan mode. Or, depending on the direction of the CEC, outlaw the parallel and mandate that the series be limited to ECM as you have currently done.

Sincerely,

Gus Faris